SPE 94171

Problems Which Can Occur During Coiled Tubing—Case Study: Hassi R'mel Field, Algeria

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This paper was prepared for presentation at the 2005 SPE/ICoTA Coiled Tubing Conference and Exhibition held in The Woodlands, Texas, U.S.A., 12 – 13 April 2005.

Abstract

Production - Pressure - PLT - RST – GHOST – CBL -Permeability - Porosity - Cement Squeeze - IP

Summary:

A non-rig Coiled Tubing Unit (CTU) cement squeeze technique has been developed and proven since years. This technique does not require that the well be killed. But problems can arrive during the operation and compromise it. For that a study was undertaken on the squeeze cement operation , realized on hassi r'mel field well .

Hassi R' mel field is a gas condensate reservoir with a superposition of three layers A - B - C having very good petrophysic characteristics and a rather significant oil rim in the Eastern and Southern peripheries.

Producing wells were drilled in the Northern part - Central - Southern with two lines of dry gas injection.

Production of water with high salinities disturbed the good production of the wells, which generated negative effects to the gas processing units.

It was necessary to decrease rate of flow of these wells to be able to decrease the volume of water, which generates a loss in the production of gas. In certain case it is necessary to close the well completely.

RST - PLT - GHOST were recorded on these wells to determine the origin of this water influx and a CBL was recorded to see the state of the cement of liners.

Following the results of the operations carried out, a study was undertaken in order to see the method to be used for the optimization of these wells:

- Avoid placing a bridge plug for the layer C, because one will lose a good part of production of gas, since this level is more prolific than the other levels.
- Isolate the places and perfos which produces water by a cement squeeze .

The purpose of this presentation is to show:

- the problems which can occur during operation of coiled tubing; and the reasons of squeeze cement failure.
- to show a real case carried out on hassi r'mel field
- the advantages and disadvantages of use the coiled tubing.
- solutions to adopt to improve the use of coiled tubing.

Introduction

This study is the complement of a preceding study "Production Optimization of Gas Wells: Problem of Water Influx "whose operation squeeze cement did not succeed.[1]

Cement has been the primary choice as the readily available and easy to apply material to shut off perforations, fractures, channels, and other undesired void spaces. This common practice of placing cement into a desired location to achieve a hydraulic seal is generally referred to as squeeze cementing[2]. But problems can occur during operation of coiled tubing; and compromise the job.

Many failures of the operations of coiled tubing were recorded in various fields throughout the world.
Among these failures, there are the failures by human error and the failures mechanical
The ideal is after each failure, the contractor and the customer join to see together the cause of the failure instead to be rejected the fault.
Statistics on causes of CT operational failures (OFs) indicate that a majority of these failures can be attributed to human error.[3]

By this study we want to add another case on Squeeze cement failure which is done in the field of Hassi R' mel.

The Hassi R' mel field is a gas condensate reservoir located 500 km South of Algiers and extends on 80 km from North to South and 60 km from East to West.
This field has 3 triassic sands designated (A - B - C) **(Fig 1)** of Keuper age separated by thick shale layer and described as follow.

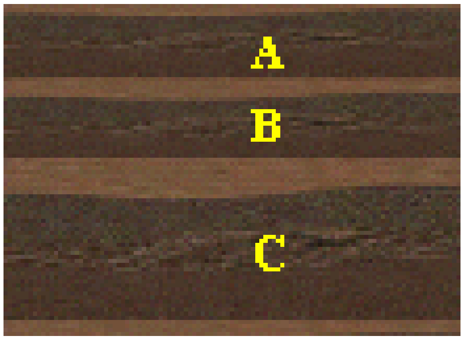


FIG 1: Layers

Layer A: Composed of fine sandstone to very fine, locally shaly, with strong anhydritic cementing. Its thickness ranges between (30 to 20 m). The average permeability is 260 md and average porosity is 15%.

Layer B: This layer is constituted of more or less shaly fine sandstones, intercalated in a series of shale and distributed in the central area of the field, which presents as channels of North–South direction.The thickness ranges from 30 m to 0 m. The average permeability is greater than 500 md in the axis of the channels, which decrease to low permeability (0.1 md on the edges) and the average porosity is 15%.

Layer C: This layer is composed of fine and medium sandstones very little cemented, with many conglomerates, and few carbonaceous. This is the thickest of the three layers, the thickness regularly ranges from North towards the South with 60 m in the Northern zone up to 0 m in the southernmost zone. It shows excellent petrophysic characteristics (average permeability 641 md, average porosity 16.8 %). It has significant net pay zone, as well as better production and storage capacities.

Production of water with high salinities disturbed the good production of the wells, which generated negative effects to the gas processing units **(Fig 2),**

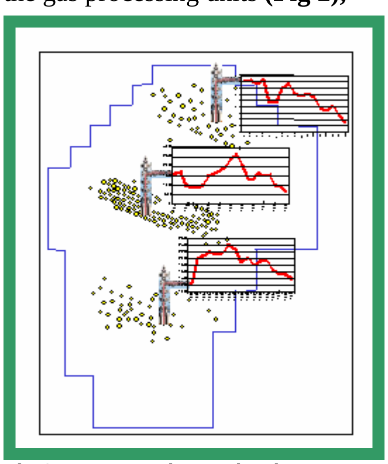


Fig 2: Decrease in Production

RST - PLT - GHOST were recorded on these wells to determine the origin of this water influx and a CBL was recorded to see the state of the cement of Liners.
With the results of the logs, a study was undertaken to see the best means to use to optimize the well and to stop water which arrives by the sides facilitated by channels.. **(Fig 5)**
Squeeze cement was retained .

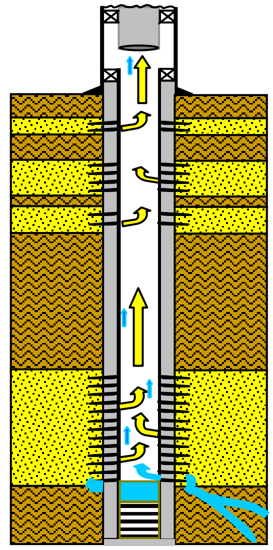


Fig 5 water is flowing up from the lowest set of perforations

Instead of posing a plug on well to isolate the layer C as for the other wells, we decided to make a squeeze cement to isolate the perfos from bottom with the method A non-rig Coiled Tubing Unit (CTU) cement squeeze technique. This technique has been developed and proven in the Prudhoe Bay field [4] and does not require that the well be killed. The channel and perforations remain clean and unobstructed allowing easy placement of cement.
The technique has been used to shut off channels in the primary cement to the aquifer , to squeeze off unwanted production perforations **(Fig 6)**.

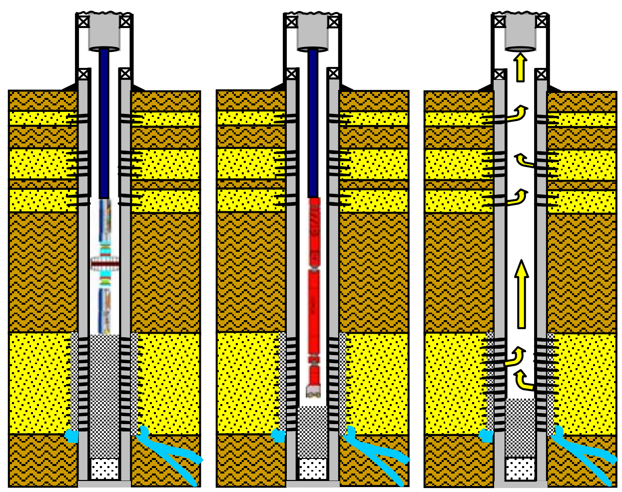
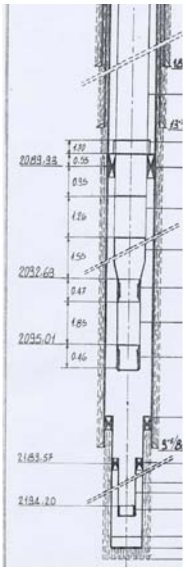


Fig 6 squeeze cement — cement drilling — perforation of the high layer C

Well data

It is a vertical gas well that is been perforated in two zones A and C. This well has water problems at high production rates.



Total depth : **2230 m**
Formation : **Trias Argilo Gréseux**
Depth Perforations : 2168.5-2169.5
2175.0-2179.0
2181.0-2184.0
2205.0-2214.5
Reservoir Pressure : 2550 psi
Permeability : 676 md
Porosity : 18 %
Frac gradient : 0.9 psi/ft
Liner : 7”26#/ft 2121-2242
Prod. Tub : 7” 29# C-95 to 2092.69m
5 ½” 15.5# 13Cr to 2095.47m
4 ½” 12.6# 2189.57m to 2194.20m
Restrictions : 4.750” @ 2092.69m
4.313” @ 2095.01m

The company of service proposed to use a coilflate Packer for this operation **(Fig 10).**

Fig 10 Coilflate Packer

Design

The best suitable solution should consider both the characteristics of the formation and CoilFLATE packer **(Fig 11)** and its limitations.

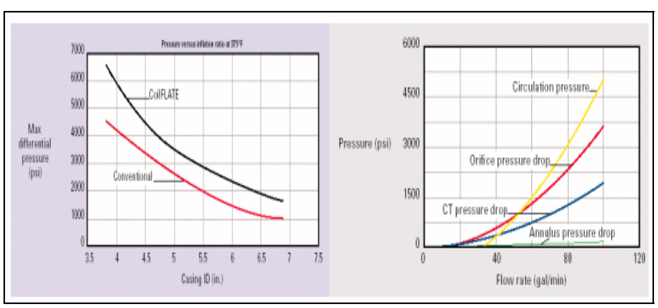


Fig 11 Characteristics of Coilflate Packer

For best results, using SqueezeCRETE is very efficient in water shut off operations due to its penetration inside the formation and to the size of the particles it is made with.

The packer will be set inside a 7” casing which will be the most limitation point. When the diameter becomes bigger the differential pressure that the packer may withstand becomes smaller. For our case the maximum differential pressure should be higher than 1500psi with the safety factor (20%) it becomes 1200psi.

Depending on the injectivity test[2], a decision will be made either pumping SqueezeCRETE, if the injectivity is bad and resistance is seen from the formation don’t pump to avoid to unset the packer by applying too much differential pressure.

A sand plug will be spotted from 2229.5m to 2219.5m in order to gain in cement volume and avoid milling longer column of cement. The main reason for using the sand is to reduce the hydrostatic pressure by reducing the volume of the cement that will reduce the length of cement inside CT.

Sand calculations

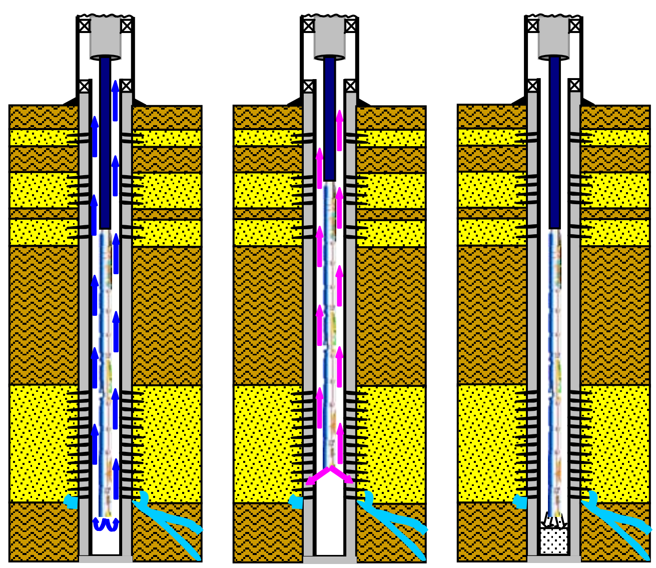
TD: 2229.5 m (based on the wire line run).
Top of the sand: 2219.5m.
Height of 7” to fill up with sand: 2229.5-2219.5 = 10 m.
Weight of sand to fill up 10 m: 22.9801lbs/ft x 10m x 3.281 = 754lbs~ (343Kg).
Gel required:
With acceptable sand slurry density of 3 ppg the volume of gel needed is:
754 lbs/ 3 ppg = 251.33 gals (6 bbls).
2 bbls of Pre-head gel and 2 bbls behind gel will be added to the total gel.
Total gel needed on location: 10 bbls.
The gel concentration required to transport the sand is: 5 kg/m3 (J457): 5x 1.6=8 kg.

Fluid volumes

Nitrogen	12 m3 (liquid)
3% KCl Treated water	48 m3
Tube Clean (7.5% HCl)	2 m3
Sand 20/40	343 Kg
Soda Ash	1 m3
Squeeze Crete Cement with additives 1 m3 (bbls)	

Tubeclean – Depth correlation – Sand plug

The first operation is to clean the well and put the sand plug **(Fig 12).**



Clean **Clean perf. With acid** **Sand plug**

Fig 12

Development of the operation

At the opening of well, wellhead pressure was 2000 psi. The coiled tubing was run in the hole without pumping.
When the CT reached the depth of 2200m, pumping started to open the valve. (0.1bpm, 0.2bpm, 0.3bpm) **(Fig 13).**

Once the flow of injection reached 0.8 bpm the valve opened. The depth correlation was correlated with the depth counter at 2194.5m (end of the 4 ½" tubing).
2m3 of clean acid of tube was pumped at 0.9bpm, followed by gel while running in hole to check TD.
TD was reached at 2228.9m, then CT was pulled up to 2200m.. At this depth the Acid at nozzle started reciprocating between 2198m to 2215m.
The TD was reached again. After the CT was pulled up 1m, the pumping started with 2bbls of gel followed by sand slurry (10bbls) displaced with 2bbls of gel and water.
Once the Sand was out of the CT, the pumping was stoped and the CT was pulling out of the hole. Once reached the surface the well was closed.

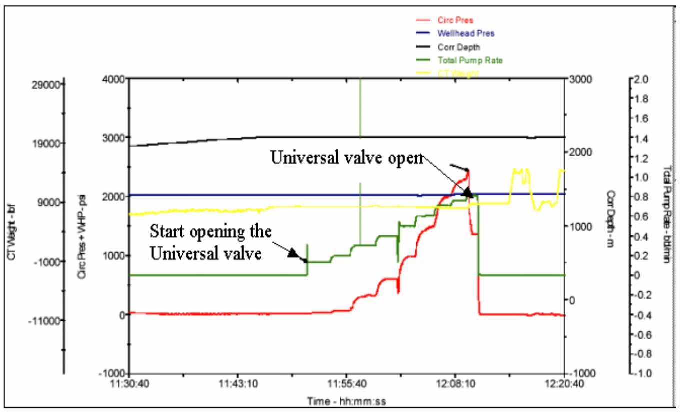


Fig 13 **Universal valve opening**

Squeeze cement- CoilFLATE

The second operation was squeeze cement

Development of the operation

At the opening of well, wellhead pressure was 1860 psi. The coiled tubing was run in the hole without pumping.
When it was at 2194.5m, the depth was correlated and the depth counter was adjusted .
The CT was run to 2201.3m and pulled up to 2199.3m (setting depth of the packer).
Pumping at 0.1bpm was started to set the packer. **(Fig 14).**
Packer was partially set, slack off weight was used.
The rate was increased to open the universal valve, but injection pressure increased fast (no good injection to the formation).
The packer was deflated.
The CT was Run in hole to check top sand, at 2217m, then it pulled out of the hole.
Once on the surface, the equipment was rigged down.

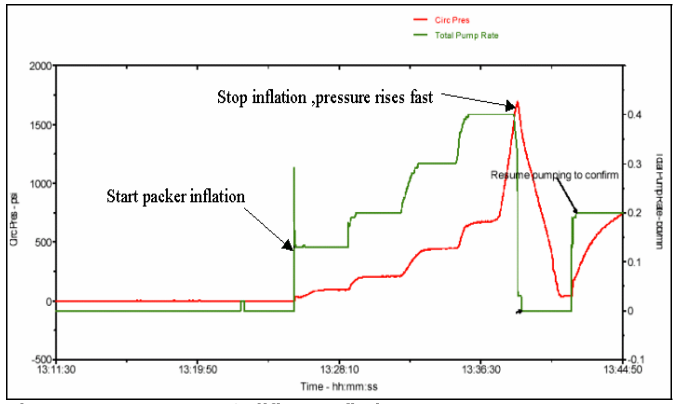


Fig 14 **Coilflate Inflation**

Causes of failure of the operation

The opperation of the squeeze cement did not succeed.
3 assumptions to be retained:

1) Possibility of the formation's resistance to injectivity.
2) Possibility that the perfos are obstructed.
3) Possibility of failure of the coilflate.

Answer:

1) The field of Hassi-R'mel is permeable with permeabilities of 1d and more, with good porosities . Water injections, gas injections and acids[5] were practised successfully on this field. Tests of reconstitution of damage on rocks with an inert oil (soltrol 130) was carried out by CRD (center of recherche)[6] during the study on acidizing. A saturated sample is subjected to the drainage with soltrol, in the direction of production of the well until establishing an irreducible water saturation. During this drainage, the permeability corresponding to a mode of stable flow, will be considered as being the initial permeability **(tab 3)** to oil of the sample.

WELLS	Depth	Kair	Ki@swi
	m	md	md
W36	2169,65	3169,00	960,50
W36	2165,40	3408,50	1051,00
W36	2180,40	2862,05	600,30
W36	2186,85	3344,20	980,25
W35	2215,20	999,64	293,50
W23	2178,80	534,28	136,20

Tab 3

Thus the possibility of the formation's resistance to injectivity can not taken into account.

2) During the clearing, the flame aspect issued from the gaz flare let us consider that the well had an open flow potential. Thus the Possibility of that the perfos were obstructed can not taken into account.

3) Thus the only possibility it is a failure of the packer as seen on the graph **(Fig 14)**. The gas oil did not reach a flow rate of 0.8 bpm which would make possible the opening of the valve. This point is not admitted by the company of service and who maintains the formation's resistance to injectivity.

Conclusion

The operation of water shut off was conducted as designed except formation characteristics are different from the expected. The cement was not pumped because of the very limited injectivity (0.1bbl/min) as explained above due probably to the faulty operation of the coilflate. The universal opening of the valve can be obstructed during the descent in the well.

The impact of an operational failure during a coiled tubing (CT) intervention is typically more severe than that of other failures because of the nature of the activity.

Running CT in and out of the well involves a high degree of human interaction and human fatigue, and short periods of inattention during this process are not uncommon.

In addition, CT failures are expensive, for both the service and operating companies.

This failure can be used for better understanding the operations of squeeze cement. By this experiment We wanted to bring a real case which will enable to determine the reasons of non-success. As explained above, several factors can be determining. The technology of squeeze cementing has been well defined in the literature[7], but practice does not reflect the technology. An operation of squeeze cement cannot often proceed according to the design traced without encountering difficulties.
These difficulties are:

- The performance of the cement slurries pumped whose depends the success of coiled tubing squeeze operation[8].
- The controlled dehydration and accurate placement of the cement slurry at a desired location.
- The formation's resistance to injectivity.
- Failures of the tools during the operation.

Recommendation

Before any work, the company of the service should control and confirm that all the tools and equipment function correctly and are compatible.

As this packer is new, it is recommended to use it with precaution.

When using an orifice sub and universal valve to inflate the coilflate packer, we should minimize the pumping rate especially in unpredictable conditions.

Proper monitoring of the pressure across the packer is recommended to avoid its unsetting .

The speed of running the packer in hole and pulling out the hole are critical in avoiding any inflation before reaching the setting depth.
Make an acidizing of the matrix to remove the doubt of the filling of the perfos after a clean out.

Using lighter fluids (diesel) to evaluate the conditions of injection of the formation before injecting cement.

Total system improvement through better service quality is obtainable through an investigation of all failures associated with CT well interventions, including those caused by equipment failure or human error.

Acknowledgments

The authors wish to thank the management of Petroleum Engeneering & Devellopement ,SH/AMT for permission to present and publish this paper.

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